EFFECT OF BALANCED FERTILIZERS ON PRODUCTIVITY OF HYBRID AND INBRED RICE VARIETIES

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ABSTRACT

Two field experiments were conducted at Rice Research and Training Center, Sakha Kafr El-Sheikh, Egypt in 2004 and 2005 summer seasons to study the effect of balanced fertilizers on productivity of hybrid and inbred rice varieties.

Six fertilizer treatments of N, P, K and Zn were applied as kg/ha. These combinations were as follows 0-0-0-0 (T_1), 165-0-0-0 (T_2), 165-36-57-0 (T_3), 165-36-0-24 (T_4), 165-0-57-24 (T_5) and 165-36-57-24 (T_6) for the four elements, respectively. Split plot design, with four replications, was used. The rice varieties were laid out in the main plots, while fertilizer treatmens were in the sub plots. The rice varieties included two hybrids (SK2034 H- and SK2047 H) and one inbred (Sakha 104). The results revealed that the hybrids were superior over the inbred in growth characters (dry matter/m^2, leaf area index and chlorophyll content), grain yield and yield components. Also, N, P, K and Zn concentrations were higher in grains and straw of hybrids than in those of the inbred. By contrast, Sakha 104 was superior over the hybrids in plant height and 1000-grain weight.

Under the experimental sites, (T_6) treatment gave the highest values of dry matter (DM), leaf area index (LAI), chlorophyll content, plant height, grain and straw yield and yield components (no. of panicles/m^2-panicle weight, no. of spikelets/panicle, no. of filled grains/panicle and 1000-grain weight) as well as the highest N, P, K and Zn concentration in grains and straw and ranked first followed by (T_3, T_4, T_5) treatments with insignificant differences existed among them which ranked second. Applying nitrogen only, (T_2) treatment was intermediate in these respects.

The interaction between rice cultivars and fertilizer treatments in both seasons were significant for DM, LAI, no. of

spikelets/panicle, no. of filled grain/panicle, no. of tillers/m^2, no. of panicles/m^2 and grain yield (t/ha)

In fact, these results may reveal that the absence of P, K and Zn show significant effect on growth, yield and its components when hybrid and inbred rice varieties were preceded by wheat, therefore, the balanced fertilizers is necessary to increase plant vigor and hence its productivity, as compared with the untreated (control) or missing application of these elements with nitrogen.

INTRODUCTION

Under Egyptian conditions, N, P, K and Zn are the essential elements to be added to rice fields to optimize production (Hamissa *et al.,* 1996). Nutrient content is related to the photosynthetic activity of leaves because essential nutrients are directly or indirectly involved in photosynthesis and respiration.

Nitrogen is the main regulator of rice productivity. Also, N is an essential fertilizer element to the growth and production of rice plant (Balal, 1981). In general, new rice varieties and hybrid rice are highly responsive to high N levels (165 kg/ha) in the form of urea or ammonium sulphate. Nitrogen should be added as 2/3 of the amount incorporated into dry soil before transplanting and 1/3 just few days before panicle initiation (PI). El-Kady and Abd El-Wahab (1999) reported that growth characters were significantly increased as N level increased up to 150 kg N/ha. They reported also, that N increased grain yield and yield components.

Phosphorus (P) deficiency occurs widely in both calcareous and alkaline soils and in soils with high-fixing capacity. Results of fertilizer experiments on Egyptian soil indicated that P application had ineffectual effect on grain and straw yields, plant height, and panicle length (RRTC 1999-2001). Optimum yield was obtained using 36 kg P_2O_5/ha.

Potassium (K) deficiency occurs in poorly drained soils, partly because toxic substances produced in highly reductive soils retard K uptake and partly because less soil K is released under poorly drained conditions. Potassium exerts a favourable influence on tillering, size and weight of grain, stimulates build-up and translocation of carbohydrates to grain by strengthening the plant cell wall, renders the crop more resistant to diseases and adverse weather (Roy, 1981). Potash fertilization had a marked influence on the overall nutrient levels in grain (Grist, 1965). Ebaid and Ghanem (2001) and Zayed (2002) found that potassium application had positive effects on growth, yield component, grain yield and N and K content.

On the other hand, the requirement of P and K is questionable since the amount of these fertilizers depend on the amounts of fertilizers added to the previous crop. One of the benefits of soil submergence is increasing the availability of P (DeDatta, 1981) and K (DeDatta and Gomez, 1982). In Egypt, 36 kg P_2O_5 and 57 kg K_2O/ha are recommended.

Zinc is one of the most limiting factors affecting rice production in Egypt. Zinc deficiency was observed more frequently in soils with high pH and low organic carbon. Zinc applied to rice in flooded soils, to correct its deficiency, is subjected to transformation in various chemical forms (Viets, 1962) and DeDatta, 1983). Zinc becomes more effective when applied into a well leveled soil before transplanting (Mikkelson and Brandon, 1975). Rice growth, namely, plant height, number of tillers/m^2; LAI and dry matter content, and grain yield and its components were significantly increased when rice was fertilized with zinc, (Gorgy 1988 and Gorgy *et al.*, 2006, Ghanem *et al.* 1992 and Metwali 2002).

Sakal and Sinha (1983) reported that P contents in all plant parts decreased with Zn and Fe application, while Zn increased K content in all plant parts. A significant antagonistic effect of P and Zn affect their availability in the soil. Application of Zn to rice reduced the concentration of P and reduced translocation or absorption of Mg and P depending on the nutrient supply of soil, in the same time increased Zn concentration (Verma and Neue 1984 and Cayton *et al.*, 1985).

Duraisamy *et al.* (1986) indicated that application of Zn increased the available N content and reduced the available P content. The application of N, P, K and Zn to rice plant caused an increase in plant height, number of tillers, number of panicles/m^2 and grain yield (Ghanem *et al.*, 1992). Kasturi and Burushothaman (1992) found that the grain yield and 1000-grain weight were highest with the combination of NPK and increasing N levels increased N, K concentration in rice grain and straw. Parida *et al.*

(1995) reported that addition of K to N and P increased yield compared with N + P or N alone. Application of $ZnSO_4$ to crops receiving NPK did not significantly affect yield but increased protein content. Khanda and Dixit (1995) reported that application of Zn + N increased grain yield compared with N alone.

Nitrogen application increased plant N, K and Ca concentrations (Yun *et al.*, 1996).

Hammad *et al.* (1998) found that application of urea resulted an increase in N content of rice grain and straw as compared with ammonium sulfate treated soil. While, Gewaily (2001) mentioned that increasing N levels up 90 kg N/fed. increased N, K concentration in rice grain and straw and 60 kg N/fed. increased P concentration in rice grain only.

MATERIALS AND METHODS

Two field experiments were conducted at the Farm of Rice Research and Training Center, Sakha Agricultural Research Station, Kafr El-Sheikh, Egypt, during 2004 and 2005 growing seasons. The experiments aimed to study the effect of balanced fertilizers on productivity of hybrid and inbred rice varieties. The chemical and physical properties of the experimental site are shown in Table (1).

The current study was performed in split plot design with four replications, three rice varieties; SK2034 H, SK2047 H (hybrid rice) and Sakha 104 (inbred rice) were arranged in the main plots and treatments of fertilizer were allocated in the sub plots. Plot size was 15 m^2. Wheat was the previous crop in the two seasons.

Table (1): Chemical and physical properties of the experimental site.

Season	Properties												
	Clay %	Silt %	Sand %	Texture	O.M %	N %	pH	EC (dS/m)	K (mg/L)	Na (mg/L)	Ca (mg/L)	P Available (ppm)	Zn Available (ppm)
2004	56.1	31.3	12.6	Clay	1.4	0.08	7.9	1.82	470	12	4.8	12	0.70
2005	55.4	32.33	12.27	Clay	1.5	0.06	8.2	2.3	460	11	4.41	10	0.82

Phosphorus (36 kg P_2O_5/ha), potassium (57 kg K_2O/ha) and 2/3 nitrogen fertilizer (165 kg N/ha) were applied and incorporated into a dry soil before flooding and 1/3 of the N was applied before panicle initiation (PI). Zinc sulphate ($ZnSO_4$. 7 H_2O) was mixed with fine soil and manually broadcasted into the well levelled soil after puddling, just before transplanting. The treatments of N, P, K and Zn fertilizer were applied as shown in Table (2).

Table (2): The six treatments of N, P, K and Zn fertilizers.

Treatments No.	Treatments (kg/ha)			
	N	P	K	$ZnSO_4$
T_1 (control)	0	0	0	0
T_2	165	0	0	0
T_3	165	36	57	0
T_4	165	36	0	24
T_5	165	0	57	24
T_6	165	36	57	24

Two seedlings (30 days old) were planted in 9th of May in both seasons. The cultivars were transplanted 20 x 20 cm between hills and rows. All cultural practices were done up to harvesting as recommended.

Studied characters:

A. Growth analysis and attributes:

At heading, plant samples (5 hills) were collected randomly from each sub plot to determine the following:

1. Dry matter production (g/m^2);
2. Leaf area index (LAI): Leaf area was measured using leaf area meter (Model LI 3000A) and LAI was calculated;
3. Chlorophyll content, using chlorophyll meter (Model-SPAD-502);
4. Plant height (cm): At harvesting, plant height of ten random rice plants were measured from soil surface up to the top panicle of the main stem.

B. Yield and its attributes:

1. Number of tillers/m^2: number of tillers were counted in five hills, then the average number/m^2 was computed.
2. Number of panicles/m^2.

3. Panicle weight: Ten main panicles were collected randomly from each sub plot and the actual average weight was determined.
4. The number of spikelets/panicles: number of spikelets were counted from ten main panicles from each sub plot.
5. Filled grains/panicle: from ten panicles from each sub plot were recorded.
6. Grain and straw yields (t/ha): 10 m^2-area was harvested from each sub plot and the grain and straw yields were recorded and the grain yield was adjusted to 14% moisture content and converted into t/ha.

C. Chemical analysis of grains and straw:

After harvest, sub plot samples of grains and straw were dried at 70°C for 48 hr. Dried samples were ground and used to determine N, P and K % as follows: total nitrogen % was determined by the Micro Kjeldahl Method (Jackson, 1967). Phosphorus was determined colourimetrically by ascorbic acid according to Olsen and Dean (1965) and modified by Watanabe and Olseen (1965). Potassium, by using flame photometer (Jackson, 1967). Zn (ppm) was determined by using atomic adsorption (Jackson, 1967).

All data collected were subjected to the standard statistical analysis following the proceeding described by Gomez and Gomez (1984) using the computer program (IRRISTAT).

RESULTS AND DISCUSSION

A. Growth analysis and attributes:

Effect of fertilizer treatments and two rice hybrids and Sakha 104 cultivar and their interaction on dry matter (DM), leaf area index (LAI), chlorophyll content and plant height are presented in Table (3).

Data indicated that SK2034 H recorded the highest dry matter, leaf area index and chlorophyll content in both seasons, followed by SK2047 H, while Sakha 104 (inbred rice) recorded the lowest values of these traits. These data agree with those obtained by Cheng *et al.* (1989) and Yamauchi (1994) who mentioned that hybrid rice has been reported to achieve 17% to 34% more LAI and has more DM accumulation than that of conventional varieties at heading. Also, similar findings were reported by Ebaid and El-Mowafi (2005). On contrast, Sakha 104 rice cultivar recorded the highest value of plant height in both seasons.

Table (3): Effect of NPK and zinc fertilization treatments on some growth characters of hybrid and inbred rice varieties.

Treatments	Dry matter (g/m²) 2004	Dry matter (g/m²) 2005	LAI 2004	LAI 2005	Chlorophyll content 2004	Chlorophyll content 2005	Plant height (cm) 2004	Plant height (cm) 2005
	Varieties							
SK 2034 H	1356.0a	1345.5a	6.62a	7.05a	38.45a	38.9a	102.58b	103.0b
SK 2047 H	1290.3b	1268.8b	6.34b	6.39b	37.16a	38.0a	106.88a	107.0a
Sakha 104	1162.40c	1162.3c	5.58c	5.36c	35.62b	36.0b	107.9a	107.5a
N P K Zn	**Fertilizer treatments (kg/ha)**							
0 0 0 0 Cont. T_1	989.40e	969.0e	3.14e	3.22d	33.95c	34.6d	100.08d	98.4d
165 0 0 0 .... T_2	1221.1d	1199.3d	5.90d	6.18c	37.36b	37.4c	105.04c	105.3c
165 36 57 0 .... T_3	1295.50c	1290.3c	7.03b	7.11b	37.66b	38.4b	106.67bc	107.1b
165 36 0 24 .... T_4	1267.0cd	1263.0c	6.38c	6.42c	37.28b	37.6c	105.96bc	105.1c
165 0 57 24 .... T_5	1358.0b	1346.6b	7.08b	7.20b	37.59b	38.7ab	107.21b	107.8b
165 36 57 24 .... T_6	1486.0a	1484.9a	7.53a	7.49a	38.61a	39.3a	109.75a	110.3a
	Interaction							
V x F	**	**	*	**	NS	NS	NS	NS

In each column, means followed by a common letter are not significantly different at 5% level according to DMRT.

Data also indicated that NPK and Zn application significantly increased vegetative growth characters (DM, LAI, chlorophyll content and plant height (T_6) followed by (T_5) treatment while control (T_1) recorded the lowest values in these traits. Similar findings were reported by Salam and Subrammanian (1988), Kasturi and Burshothaman (1992), and Bhowmick and Nayak (2000). These results could be attributed to the role of NPK and Zn that applied to rice plant in increasing the efficiency of photosynthesis process and consequently the metabolites in plant.

The interaction between cultivars and fertilizer treatments were significant for dry matter accumulation and LAI in both seasons (Tables 4 and 5). Regarding DM, the best combination was applying all elements (N, P, K and Zn (T_6) treatment and SK 2034 hybrid rice in both seasons. Meanwhile, the worst one was none of the elements applied (T_1) treatment with Sakha 104 (Table 3). The previous finding was true with LAI too (Table 5).

The physiological basis for higher response to NPK and Zn by hybrid rice is its capacity to increase photosynthetic activity by increasing LAI and thereby more accumulation of DM. Both of these growth parameters were reported to be increased in NPK Zn application from zero to 165 kg N/ha + 36 kg P_2O_5/ha + 57 kg K_2O/ha and 24 kg $ZnSO_4$/ha. Similar findings were reported by Gorgy (1988); OM *et al.* (1997), and Zayed (2002). It is well known that Zn appliation affected growth regulation by controlling the synthesis of tryptophan from indol.

Table (4): Dry mater accumulation (g/m^2) as affected by the interaction between rice cultivars and fertilizer treatments.

Fertilizer treatment		2004			2005		
		Cultivars					
		SK2034 H	SK2047 H	Sakha 104	SK2034 H	SK2047 H	Sakha 104
0-0-0-0	T_1	1069.5 ij	1023.5 j	875.3 k	1030.8 i	989.8 i	886.5 d
165-0-0-0	T_2	1273.8 ef	1233.3 e-h	1156.3 hi	1255.1 efg	1206.5 gh	1136.3 h
165-36-57-0	T_3	1376.8 cd	1304.8 def	1205.0 fgh	1363.3 cd	1295.0 def	1212.5 efg
165-36-0-24	T_4	1299.0 def	1264.0 efg	1239.3 e-h	1309.5 cde	1259.0 efg	1220.5 fg
165-0-57-24	T_5	1483.3 b	1418.8 bc	1172.0 gh	1473.0 b	1381.8 c	1185.0 gh
165-36-57-24	T_6	1634.0 a	1497.3 b	1326.8 cde	1641.3 a	1480.5 b	1333.0 cde

Means followed by a common letter are not significantly different at 5% level according to DMRT.

Table (5): Leaf area index (LAI) as affected by the interaction between rice cultivars and fertilizer treatments.

Fertilizer treatment		2004			2005		
		Cultivars					
		SK2034 H	SK2047 H	Sakha 104	SK2034 H	SK2047 H	Sakha 104
0-0-0-0	T_1	3.13 i	3.23 i	3.05 i	3.48 h	3.31 h	2.86 i
165-0-0-0	T_2	6.23 efg	6.03 fgh	5.46 h	7.14 d	6.22 e	5.17 g
165-36-57-0	T_3	7.55 bc	7.13 cd	6.42 efg	8.09 ab	7.08 d	6.16 e
165-36-)-24	T_4	6.80 de	6.47 efg	5.88 gh	7.23 cd	6.39 e	5.63 f
165-0-57-24	T_5	7.76 ab	7.35 bcd	6.14 fg	7.97 ab	7.62 bc	6.02 ef
165-36-57-24	T_6	8.24 a	7.83 ab	6.54 ef	8.43 a	7.73 b	6.31 e

Means followed by a common letter are not significantly different at 5% level according to DMRT.

B. Yield and its attributes:

B.1. Panicle weight, number of spikelets/panicle, number of filled grains/panicle and 1000-grain weight:

Data in Table (6) present the effect of rice cultivars and fertilizers treatments and their interaction on panicle weight, no. of spikelets/panicle, no. of filled grains/panicle and 1000-grain weight in 2004 and 2005 seasons.

Data showed that significant differences were observed among hybrid and inbred rice varieties in panicle weight. Data indicated that SK2034 H recorded the highest panicle weight, followed by SK2047 H, while, Sakha 104 rice cultivar recorded the lowest values in this trait in both seasons.

Table (6): Effect of NPK and zinc fertilization on grain yield components (panicle weight, no. of spikelets/panicle, no. of filled grain/panicle and 1000-grain weight) in two hybrids and Sakha 104 rice cultivars.

Treatments	Panicle weight (g)		No. of spikelets/panicle		No. of filled grain/panicle		1000-grain weight	
	2004	2005	2004	2005	2004	2005	2004	2005
	Varieties							
SK 2034 H	3.46 a	3.50 a	186.850 a	179.20 a	167.4 a	170.90 a	24.34 c	24.39 c
SK 2047 H	3.27 b	3.34 b	180.70 a	175.60 a	165.2 a	169.0 a	25.54 b	25.56 b
Sakha 104	3.22 b	3.21 c	119.9 b	117.94 b	110.0 b	111.70 b	26.13 a	26.14 a
N P K Zn	**Fertilizer treatments (kg/ha)**							
0 0 0 0 Cont. T_1	2.14 e	2.17 e	126.90 c	114.58 d	107.30 c	103.50 e	24.31 d	24.35 d
165 0 0 0 T_2	3.26 d	3.33 d	162.50 b	162.87 bc	143.90 b	155.20 c	24.96 c	25.03 c
165 36 57 0 T_3	3.50 c	3.58 b	167.20 b	165.0 b	152.30 b	161.0 b	25.39 b	25.42 b
165 36 0 24 T_4	3.47 c	3.45 c	162.40 b	157.81 c	148.4 b	148.5 d	25.59 b	25.44 b
165 0 57 24 T_5	3.64 b	3.68 b	164.10 b	162.90 bc	152.50 b	158.40 cb	25.56 b	25.56 b
165 36 57 24 T_6	3.87 a	3.89 a	191.70 a	182.32 a	180.90 a	176.60 a	26.21 a	26.38 a
	Interaction							
V x F	NS	NS	**	**	*	*	NS	NS

In each column, means followed by a common letter are not significantly different at 5% level according to DMRT.

Data indicated that no significant differences were observed between SK2034 H and SK2047 H in no. of spikelets/panicle and no. of filled grains/panicle, while Sakha 104 recorded the lowest values in these traits in 2004 and 2005 seasons.

Concerning 1000-grain weight, Sakha 104 recorded the highest values, followed by SK2047 H while, SK2034 H recorded the lowest in both seasons. The current findings agree with those reported by Bhowmick and Nayak (2000) and Ebaid and El-Mowafi (2005).

The application of NPK and Zn altogether (T_6) significantly increased panicle weight, no. of spikelets/panicle and No. of filled grains/panicle over the control. Missing of K with N (T_4) decreased panicle weight in the two season and reduced no. of spikelets/panicle and no. of filled grains/panicle in 2005 season. Data, also, revealed no significant differences among T_3, T_4 and T_5 treatments on 1000-grain weight in both seasons. These data are in agreement with those of Roy (1981), Ebaid and Ghanem (2001) and Zayed (2002). The obtained beneficial effect of P can be ascribed to its effects on the photosynthetic process in addition to its structural role in building up different components which reflected in seed yield and its components

The interaction between three rice cultivars and six fertilizer treatments were significant for number of spikelets/panicle and number of filled grain/panicle in both seasons (Tables 7 and 8).

Table (7): Number of spikelets/panicle as affected by the interaction between rice cultivars and fertilizer treatments.

Fertilizer treatment		2004			2005		
		Cultivars					
		SK2034 H	SK2047 H	Sakha 104	SK2034 H	SK2047 H	Sakha 104
0-0-0-0	T_1	140.3 e	133.4 ef	107.1 h	127.5 ef	121.2 ef	95.05 g
165-0-0-0	T_2	188.8 cd	175.3 d	123.4 fg	183.43 cd	181.0 cd	124.18 ef
165-36-57-0	T_3	192.1 c	191.1 c	118.4 gh	187.38 c	188.2 c	119.43 f
165-36-0-24	T_4	183.8 cd	184.3 cd	119.1 gh	177.43 cd	175.0 d	120.5 ef
165-0-57-24	T_5	187.0 cd	189.1 cd	116.2 gh	183.20 cd	188.75 c	116.75 f
165-36-57-24	T_6	228.6 a	211.2 b	135.3 ef	216.25 a	198.98 b	131.73 e

Means followed by a common letter are not significantly different at 5% level according to DMRT.

Table (8): Number of filled grains/panicle as affected by the interaction between rice cultivars and fertilizer treatments.

Fertilizer treatment		2004			2005		
		Cultivars					
		SK2034 H	SK2047 H	Sakha 104	SK2034 H	SK2047 H	Sakha 104
0-0-0-0	T_1	116.4 de	111.3 de	94.2 e	114.4 ef	109.9 f	86.1 g
165-0-0-0	T_2	162.7 c	159.0 c	110.1 de	173.5 cd	174.0 cd	118.2 ef
165-36-57-0	T_3	170.4 c	176.0 c	110.4 de	183.9 bc	182.1 bc	117.1 ef
165-36-0-24	T_4	167.6 c	168.7 c	108.6 de	166.4 d	168.5 d	110.6 f
165-0-57-24	T_5	173.1 c	177.4 bc	107.2 de	178.5 cd	185.0 bc	111.6 f
165-36-57-24	T_6	214.6 a	198.7 ab	129.4 d	208.7 a	194.9 b	126.4 e

Means followed by a common letter are not significantly different at 5% level according to DMRT.

Data in Table (7), showed that the best combination between rice varieties and fertilizer treatments for obtaining the largest number of spikelets/panicle was applying all elements(T_6 treatment) for SK2034 H which produced 228.6 and 216 spikelets/panicle in 2004 and 2005, respectively. On contrast, the lowest number of spikelets/panicle (107.1 and 95.05) in both seasons was obtained when Sakha 104 was transplanted without applying any elements (T_1). This previous finding was true with number of filled grain/panicle too (Table 8). The data revealed that applying NPK and Zn (T_6) to hybrids gave the highest number of filled grain/panicle. Cultivating Sakha 104 with zero fertilizer (T_1) gave the lowest number of filled grain/panicle in both seasons. Salam and Subramanian (1988), Sharma (1992) and Pan *et al.* (1992) found that Zn application increased N, P, Z an Fe uptake by rice plant. Also, the concentration of N, P, K; S and trace elements in rice grains were increased with N application so, these elements increased number and filled grains/panicle, and heaviest 1000-grain weight.

B.2. number of tillers/m², number of panicles/m², straw and grain yields:

Data in Table (9) present the effect of rice cultivars and fertilizer treatments and their interaction on number of tillers/m², number of panicles/m² straw and grain yields in 2004 and 2005 seasons.

Data showed significant differences among the three cultivars in number of tillers/m², number of panicles/m² and straw yield where hybrid rice (SK2034 H) produced larger no. of tillers/m^2, no. of panicles/m^2 and straw yield and ranked first followed by hybrid rice (SK2047 H) where, Sakha 104 (inbred rice) gave the lowest values of these traits.

Data showed that grain yield was highly significant influenced by the three varieties in both seasons. Hybrids rice (SK2034 H and SK2047 H) gave the highest grain yield with non-significant difference between them while, Sakha 104 (inbred rice) recorded the lowest. This result may be interpreted by the fact that heterosis of yield in hybrid rice was found to come mostly from vegetative growth, spikelets/panicle and panicle weight (Rao *et al.*, 1985) and these results are in harmony with those reported by IRRI (1988) and Lin (1994) who mentioned that rice hybrids were found to give 1.0 to 1.8 t/ha more yields than inbreds, even at the same level of inputs, and the yield advantage of hybrid rice over conventional modern varieties is about 19%.

Regarding the effect of fertilizer treatments on these traits, results showed that applying NPK and Zn (T_6) outyielded significantly the other treatments and ranked first followed by T_3, T_4 and T_5 which ranked second and T_1 was last in these respects. The superiority of (T_6) treatment over the others could be attributed to yield components viz. no. of panicles/m^2, panicle weight, no. of spikelets/panicle and no. of filled grains/panicle as well as 1000-grain weight. Also, balanced fertilization using NPK and Zn was found to reduce disease, lodging and increase grain yield (Osman *et al.*, 2002). Uptake of N, K and P in grain and straw increased significantly due to N application, in the same time, zinc application (25 kg $ZnSO_4$/ha) increased N, P, Zn and Fe uptake by rice plant (Faizy *et al.*, 1997), (Paliwal *et al.*, 1997); and (Subranmanian, 1988).

The interaction between fertilizer treatments and rice varieties were significant for tillers (Table 10) and panicles numbers (Table 11), in both seasons. Data documented in Tables (10 and 11) showed that SK2034 hybrid rice with T_6 gave the highest number of tillers and panicles/m^2 in both seasons. Sakha 104 (inbred rice) variety with zero fertilizer (T_1) gave the lowest values of tillers and panicle number/m^2 in both seasons.

Table (9): Effect of NPK and zinc fertilization on no. of tillers/m^2, straw yield and grain yields in two hybrids and Sakha 104 rice cultivars.

Treatments	No. of tillers/m^2		No. of panicles/m^2		Straw yield (t/ha)		Grain yield (t/ha)	
	2004	2005	2004	2005	2004	2005	2004	2005
	Varieties							
SK 2034 H	544.4 a	532.5 a	486.0 a	503.0 a	13.38 a	13.55 a	10.65 a	10.78 a
SK 2047 H	523.1 b	518.9 a	479.3 a	481.69 b	12.77 b	12.83 b	10.36 a	10.47 a
Sakha 104	454.2 c	449.0 b	446.5 b	431.80 c	11.14 c	11.17 c	9.19 b	9.46 b
N P K Zn	**Fertilizer treatments (kg/ha)**							
0 0 0 0 Control T_1	379.2 d	355.3 d	300.7 d	314.0 e	11.09 c	11.26 c	5.10 d	5.30 d
165 0 0 0 .... T_2	455.6 c	451.7 c	413.4 c	423.89 d	12.37 b	12.49 b	9.59 c	9.80 c
165 36 57 0 .... T_3	535.7 b	537.2 b	528.4 a	512.05 bc	12.75 a	12.82 ab	11.27 b	11.34 b
165 36 0 24 .... T_4	563.6 a	545.1 a	528.0 a	525.15 ab	12.70 ab	12.80 ab	11.03 b	11.30 b
165 0 57 24 .... T_5	540.2 b	539.5 b	506.8 b	505.47 c	12.72 ab	12.80 ab	11.17 b	11.51 b
165 36 57 24 .... T_6	568.9 a	572.7 a	546.1 a	550.51 a	12.97 a	12.94 a	12.24 a	12.18 a
	Interaction							
V x F	**	**	*	*	NS	NS	**	**

In each column, means followed by a common letter are not significantly different at 5% level according to DMRT.

Table (10): Number of tillers/m^2 as affected by the interaction between rice cultivars and fertilizer treatments.

Fertilizer treatment		2004			2005		
		Cultivars					
		SK2034 H	SK2047 H	Sakha 104	SK2034 H	SK2047 H	Sakha 104
0-0-0-0	T_1	410.7 ef	393.0 f	334.0 g	371.3 f	380.8 f	313.8 g
165-0-0-0	T_2	491.8 c	450.4 d	424.6 def	474.3 cd	455.5 d	425.3 e
165-36-57-0	T_3	596.4 ab	577.8 ab	432.9 de	585.5 ab	568.5 b	457.7 d
165-36-0-24	T_4	596.5 ab	579.6 ab	514.9 c	580.5 b	566.3 b	468.5 cd
165-0-57-24	T_5	563.4 b	565.9 b	491.4 c	570.0 b	564.3 b	484.3 cd
165-36-57-24	T_6	607.4 a	572.0 ab	527.3 e	613.3 a	578.3 b	526.6 c

Means followed by a common letter are not significantly different at 5% level according to DMRT.

Table (11): Number of panicles/m^2 as affected by the interaction between rice cultivars and fertilizer treatments.

Fertilizer treatment		2004			2005		
		Cultivars					
		SK2034 H	SK2047 H	Sakha 104	SK2034 H	SK2047 H	Sakha 104
0-0-0-0	T_1	288.3 i	317.0 i	297.0 i	338.5 j	310.3 jk	293.3 k
165-0-0-0	T_2	428.9 g	418.3 gh	393.1 h	449.7 gh	426.8 hi	395.2 i
165-36-57-0	T_3	556.6 ab	539.6 bc	489.0 ef	562.3 ab	544.0 bcd	429.9 hi
165-36-0-24	T_4	548.8 abc	532.7 bcd	502.5 def	557.9 abc	539.2 bcd	480.4 ef
165-0-57-24	T_5	518.5 cde	526.0 bcd	476.0 f	523.0 b-e	520.8 cde	472.7 fg
165-36-57-24	T_6	575.0 a	542.3 abc	521.2 b-e	586.6 a	549.2 a-d	515.8 de

Means followed by a common letter are not significantly different at 5% level according to DMRT.

The interaction between fertilizer treatments and rice varieties were significant for grain yield in both seasons (Table 12). The best combination was T_6 with SK 2034 hybrid rice in grain yield. These results are similar to those reported by Khanda and Dixit (1995).

Table (12): Grain yield (t/ha) as affected by the interaction between rice cultivars and fertilizer treatments in 2004 and 2005 seasons.

Fertilizer treatment		2004			2005		
		Cultivars					
		SK2034 H	SK2047 H	Sakha 104	SK2034 H	SK2047 H	Sakha 104
0-0-0-0	T_1	5.38 h	5.08 h	4.83 h	5.69 j	5.36 j	4.84 k
165-0-0-0	T_2	9.73 fg	9.78 fg	9.27 g	10.12 gh	9.91 h	9.36 l
165-36-57-0	T_3	11.98 b	11.62 bc	10.21 ef	11.96 cd	11.67 d	10.39 fgh
165-36-0-24	T_4	11.57 bc	11.23 cd	10.29 ef	11.67 d	11.51 d	10.72 ef
165-0-57-24	T_5	11.98 b	11.68 bc	9.86 fg	12.22 bc	11.83 cd	10.50 efg
165-36-57-24	T_6	13.27 a	12.75 a	10.69 de	13.05 a	12.56 b	10.94 e

Means followed by a common letter are not significantly different at 5% level according to DMRT.

C. Chemical analysis of grains and straw:

Data in Table (13) present the concentration of N, P, K and Zn in grains and rice straw of two hybrids rice and Sakha 104 (inbred rice) as affected by fertilizer treatments and their interactions in 2004 and 2005 seasons.

Results of N, P, K and Zn concentration in grains and rice straw showed that highly significant differences were existed among three rice varieties in both seasons. Where SK2034 H had higher values, followed by SK1047 H, while, Sakha 104 (inbred rice) gave the least in both seasons. This might be due to the higher response of hybrid rice to NPK and Zn fertilizer than inbred rice. Also, superiority of hybrids in root growth over their parents helped in utilizing the applied fertilizer more efficiently. Hybrids have stronger and more active root system at early and middle growth stages (Sahai and Choudhary, 1986) and (Cheng *et al.,* 1989). These results agree with those of Chengxiu and Shangxian (1988) who reported that rice hybrids had higher N, P, N and K uptake by 3.2, 7.8 and 12.7%, respectively as compared to conventional varieties.

Application of balanced fertilization (T_6) using 165 N + 36 P + 57 K and 24 Zn/ha, gave the highest N, P, K and Zn concentration in rice grains and straw while, untreated plants (T_1) gave the lowest concentration of these elements in both grains and straw in 2004 and 2005 seasons. The data are in agreement with those reported by Kasturi and Burshothaman (1992) and Pan *et al.* (1992).

In general, phosphorus concentration in grains and straw increased markedly when P was applied (T_6, T_4 and T_3). Potassium concentration decreased in grains and straw in T_1, T_2 and T_4. This reduction might be due to the missing application of K in these treatments. These results are in harmony with those reported by Pan *et al.* (1992) and Gewaily (2001).

Data in Table (13) indicated that the highest Zn concentration in grains and straw in both seasons was obtained when plants were fertilized with zinc (T_6, T_5 and T_4) while, the lowest Zn concentration in both grains and straw was obtained when no zinc was added (T_1, T_2 and T_3). These results are in agreement with those reported by Verma and Neue (1984), Metwali (2002) and Gorgy *et al.* (2006).

Table (13): Concentration of N, P, K (%) and Zn (ppm) in grains and straw of three rice varieties as affected by fertilizer treatments.

Treatments	2004								2005							
	N %		P %		K%		Zn (ppm)		N %		P %		K%		Zn (ppm)	
	Grains	Straw	Grains	Straw	Grains	Straw	Grains	Straw	Grains	Straw	Grains	Straw	Grains	Straw	Grains	Straw
	Varieties															
SK 2034 H	1.210 a	0.213 a	0.169 a	0.119 a	0.377 a	1.009 a	82.3 a	180.61 a	1.216 a	0.219 a	0.170 a	0.128 a	0.362 a	1.02 a	80.66 a	180.6 a
SK 2047 H	1.204 a	0.209 a	0.167 a	0.119 a	0.3748 a	0.952 b	82.43 a	177.99b	1.171 b	0.214 a	0.168 a	0.127 a	0.356 b	0.967 b	80.79 a	177.96b
Sakha 104	1.18 b	0.199 b	0.163 b	0.115 b	0.310 b	0.915 b	79.57 b	172.65 c	1.162 c	0.205 b	0.162 b	0.121 b	0.295 c	0.931 c	78.26 b	172.64 c
N P K Zn	**Fertilizer treatments (kg/ha)**															
0 0 0 0 Cont. T_1	0.882 c	0.157 f	0.144 e	0.104 c	0.290 d	0.827 d	77.66 c	161.54 e	0.804 d	0.161 e	0.142 e	0.110 c	0.255 f	0.824 e	75.22 c	158.6 c
165 0 0 0 T_2	1.252 b	0.199 e	0.154 d	0.113 b	0.311 c	0.892 c	79.72 b	166.87d	1.242 c	0.203 d	0.155 d	0.121 b	0.291 e	0.913 d	78.28 b	168.09b
165 36 57 0 T_3	1.266 ab	0.225 b	0.177 b	0.122 a	0.394 b	1.034 ab	81.10 b	170.56 c	1.259 b	0.230 b	0.1777b	0.130 a	0.374 c	1.053 b	79.66 b	171.78b
165 36 0 24 T_4	1.257 b	0.211 d	0.180 a	0.124 a	0.317 c	0.913 c	83.01 a	185.33b	1.250 c	0.219 c	0.181 a	0.131 a	0.327 d	0.933 c	81.57 a	186.5 a
165 0 57 24 T_5	1.263 b	0.219 c	0.161 c	0.115 b	0.407 ab	1.019 b	83.70 a	188.3 ab	1.257 b	0.217 c	0.168 c	0.123 b	0.387 b	1.039 b	82.26 a	189.58 a
165 36 57 24 T_6	1.28 a	0.232 a	0.181 a	0.127 a	0.411 a	1.065 a	83.4 a	189.8 a	1.2749 a	0.240 a	0.183 a	0.134 a	0.392 a	1.084 a	82.42 a	191.03 a
	Interaction															
V x F	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

In each column, means followed by a common letter are not significantly different at 5% level according to DMRT.

In both seasons, the interactions between the abovementioned two factors were insignificant for N, P, K and Zn concentration in grains and straw.

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تأثير التسميد المتوازن على إنتاجية أصناف الأرز الهجين والاصناف المرباة داخليا

رفعت نصيف جورجى

مركز البحوث الزراعية ، مركز البحوث والتدريب فى الأرز سخا ـ كفرالشيخ ـ مصر

أقيمت تجربتان حقليتان بمركز البحوث والتدريب فى الأرز بسخا كفرالشيخ موسمى صيف ٢٠٠٤م ، ٢٠٠٥م لدراسة تأثير التسميد المتوازن على إنتاجية أصناف الأرز الهجين والاصناف المرباه داخليا. وقد شملت المعاملات السمادية المستعملة إضافة عناصر النيتروجين والفوسفور والبوتاسيوم والزنك (كيلو جرام/هكتار) فى ست مجموعات من المعاملات السمادية وهى:

صفر-صفر-صفر-صفر (T1) ، ١٦٥-صفر-صفر-صفر (T2) ،
١٦٥-٣٦-٥٧-صفر (T3) ، ١٦٥-٣٦-صفر-٢٤ (T4) ،
١٦٥-صفر-٥٧-٢٤ (T5) ، ١٦٥-٣٦-٥٧-٢٤ (T6) كيلو جرام/هكتار على الترتيب.

وقد استخدم تصميم القطع المنشقة فى أربعة مكررات حيث احتوت القطع الرئيسية على الأصناف SK2034 H ، SK2047 H ، Sakha 104 والمعاملات السمادية فى القطع المنشقة. ويمكن تلخيص أهم النتائج كما يلى:

- تقوفت أصناف الأرز الهجين (SK2034 H ، SK2047 H) على الصنف Sakha 104 (المربى داخليا) فى صفات النمو (المادة الجافة بالمتر المربع دليل مساحة الورقة محتوى الكلوروفيل فى الأوراق). كذلك محصول

الحبوب والقش ومعظم مكونات المحصول. أيضا تفوقت أصناف الأرز الهجينية معنويا فى النسبة المئوية للنيتروجين والفوسفور والبوتاسيوم والزنك فى كل من الحبوب والقش مما يدل على قدرة تلك الهجن على الاستفادة من العناصر السمادية المضافة إليها. بينما أعطى الصنف Sakha 104 أعلى قيمة لطول النبات ووزن الألف حبة فى كلا الموسمين.

وتحت ظروف التجربة المقامة فقد أدى التسميد بالمعاملة (T6) والتى اشتملت على جميع العناصر السمادية (NPK and Zn) إلى زيادة معنوية فى صفات النمو (المادة الجافة دليل مساحة الورقة محتوى الكلوروفيل فى الأوراق وطول النبات) وكذلك أعطت أعلى محصول للحبوب والقش (طن/هكتار) وكذلك مكونات المحصول (عدد الداليات/م٢ — وزن الدالية — عدد السنيبلات فى الدالية — عدد الحبوب الممتلئة بالدالية — ووزن الألف حبة) وكذلك النسبة المئوية للنيتروجين والفوسفور والبوتاسيوم والزنك فى الحبوب والقش. وتلى تلك المعاملة كل من المعاملات T5, T4, T3 والتى اشتملت على العناصر (NPK) ، (NP ، Zn) (NK Zn) على الترتيب وبدون فروق معنوية بين المعاملات الثلاث السابقة وقد أعطت المعاملة (T2) والتى اشتملت على النيتروجين فقط قيما متوسطة للقياسات السابقة بنيما كانت المعاملة (T1) هى أقل القيم للصفات المدروسة فى كلا الموسمين.

كما أظهرت النتائج ايضا ان التداخل بين الاصناف والمعاملات السمادية كان معنويا فى صفات (المادة الجافة بالمتر المربع — دليل مساحة الاوراق — عدد السنيبلات/الدالية — عدد الحبوب الممتلئه بالدالية — عدد الافرع/م٢ — عدد السنابل/م٢ — محصول الحبوب "طن هكتار"

ومن النتائج السابقة وتحت ظروف هذا البحث يتضح أنه باضافة العناصر السمادية الرئيسية من النيتروجين والفوسفور والبوتاسيوم والزنك وبالمعدلات المتزنة يمكن الحصول على أعلى إنتاجية من أصناف الأرز الهجين والتى تحتاج إلى تسميد متكامل ومتوازن خاصة إذا زرعت بعد المحاصيل النجيلية مثل القمح.